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TEST REPORT

FCC/ISED 79 GHz Radar Test for MAR110

APPLICANT
HYUNDAI MOBIS CO., LTD.

REPORT NO.
HCT-RF-2103-FI001-R1

DATE OF ISSUE
March 12, 2021

Tested by
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Additional Model
-

Applicant	**HYUNDAI MOBIS CO., LTD.** 203, Teheran-ro, Gangnam-gu, Seoul, 135-977, South Korea (06141)
Eut Type	Short Range Radar
Model Name	MAR110
FCC ID	TQ8-MAR110
IC	5074A-MAR110
Date of Test	February 18, 2021~ March 08, 2021
Test Standard Used	Part 95(m), RSS-GEN issue 5, RSS-251 issue 2
Frequency Range	77 GHz ~ 81 GHz
FCC Classification	Vehicular Radar Systems (VRD)
Max. RF Output Power	Peak: 25.91 dBm (Long Range) Aver: 20.71 dBm (Long Range) Peak: 23.07 dBm (Mid Range) Aver: 20.73 dBm (Mid Range) Peak: 17.88 dBm (High Resolution) Aver: 19.43 dBm (High Resolution)

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test results were applied only to the test methods required by the standard.

REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	March 08, 2021	Initial Release
1	March 12, 2021	We have modified the Power Table. We added a note on page 18.

Engineering Statement:
The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC/ISED Rules under normal use and maintenance.

CONTENTS

1. EUT DESCRIPTION

Model	MAR110		
EUT Type	Short Range Radar		
EUT Serial Number	AC0L200633		
Power Supply	DC 9 V ~ 16 V		
Frequency Range	77 GHz ~ 81 GHz		
EIRP	Long Distance	Peak	25.91 dBm
		Average	20.71 dBm
	Mid Distance	Peak	23.07 dBm
		Average	20.73 dBm
	High Distance	Peak	17.88 dBm
		Average	19.43 dBm
Modulation Type	FMCW		
Antenna Specification	Antenna type: Micro-strip Patch Antenna Peak Gain(dBi): Azimuth : 12.49, Elevation : 10.79 Maximum Dimension(㎜): 35.384		
Date(s) of Tests	February 18, 2021~ March 08, 2021		
PMN (Product Marketing Number)	MAR110		
HVIN (Hardware Version Identification Number)	MAR110		
FVIN (Firmware Version Identification Number)	N/A		
HMN (Host Marketing Name)	N/A		

2. TEST METHODOLOGY

The measurement procedure described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) Operating Under §95(m)" were used in the measurement.

2.1 EUT CONFIGURATION

The EUT configuration for testing is installed on EIRP measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx Frequency that was for the purpose of the measurements.

2.3 GENERAL TEST PROCEDURES

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1 GHz. Above 1 GHz with 1.5 m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set far-field distance away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

2.4 DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.
Especially, all antenna(Up to 40 GHz) for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

4. FACILITIES AND ACCREDITATIONS

4.1 FACILITIES

The SAC(Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22. Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032)
For ISED, test facility was accepted dated February 14, 2019 (CAB identifier: KR0032).

4.2 EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements. Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4:2014.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence.

Parameter	Expanded Uncertainty (± dB)
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.05
Radiated Disturbance (40 GHz ~ 243 GHz)	4.59

6. SUMMARY TEST OF RESULTS

Test Description	FCC Part / ISED Section(s)	Test Limit	Test Condition	Test Result
Occupied Bandwidth	§ 2.1049 / RSS-GEN, Section 6.7	FCC: N/A ISED: 76-81 GHz	RADIATED	PASS
Radiated Power	§ 95.3367(a)(b) / RSS-251, Section 8.1, 9.1	< EIRP 50 dBm (Average) < EIRP 55 dBm (Peak)		PASS
Unwanted emissions	§ 95.3379(a)(1)(2) / RSS-GEN, Section 6.13 RSS-251, Section 10	0.009 – 0.490 MHz: 2400/F[kHz] 0.490 – 1.705 MHz: 24000/F[kHz] 1.705 – 30.0 MHz: 30 dBuV/m 30 – 88 MHz: 30.0 dBuV/m 88 – 216 MHz: 33.5 dBuV/m 216 – 960 MHz: 36.0 dBuV/m 960 – 40 000 MHz: 54 dBuV/m 40 – 200 GHz: -1.7 dBm 200 – 243 GHz: +0.5 dBm		PASS
Fundamental Emissions(Frequency stability)	§ 95.3379(b) / RSS-GEN, Section 8.11 RSS-251, Section 11	76 – 81 GHz		PASS

- All tests is performed by radiated measurement and applied below conditions.

: Used measurement distance with far field of test such as EIRP, OBW and Band edge are as follow.

Wavelength = Speed of light / Measurement frequency = 30 / 7 900 = 0.0037

(2 X (Max antenna length of EUT)^2) / Wavelength = (2 X 0.047886)^2 / 0.0038 = 0.66 m

: Spurious emissions measurement distance is shown in table below. (Far field)

Frequency Rage (GHz)	Wavelength (cm)	Far Field Distance (m)	Measured Distance (m)
18 ~ 40	0.75	2.46	3.0
40 ~ 60	0.50	1.35	1.5
60 ~90	0.33	0.85	1.5
90 ~ 140	0.21	0.57	1.5
140 ~ 220	0.14	0.36	1.5
220 ~ 243	0.12	0.18	1.5

7. TEST RESULT

7.1 OCCUPIED BANDWIDTH MEASUREMENT

Test Requirements and limit, § 2.1049

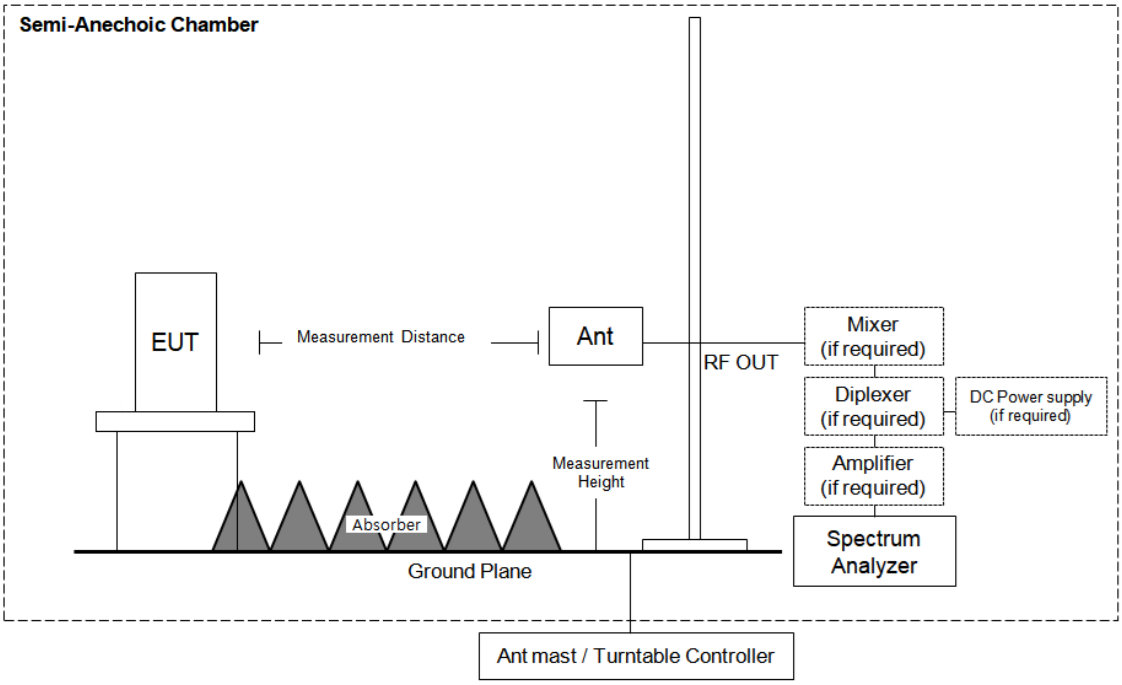
The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

ISED Rules

RSS-GEN, 6.7 Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

RBW = 1% to 3% of the 99% bandwidth.

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : 1. We tested Occupied Bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer.

▣ TEST RESULTS

TEST CONDITIONS:		Occupied Channel Bandwidth
T nom	V nom	427.396 MHz

*** Long Range**

TEST CONDITIONS:		Occupied Channel Bandwidth
T nom	V nom	669.473 MHz

*** Mid Range**

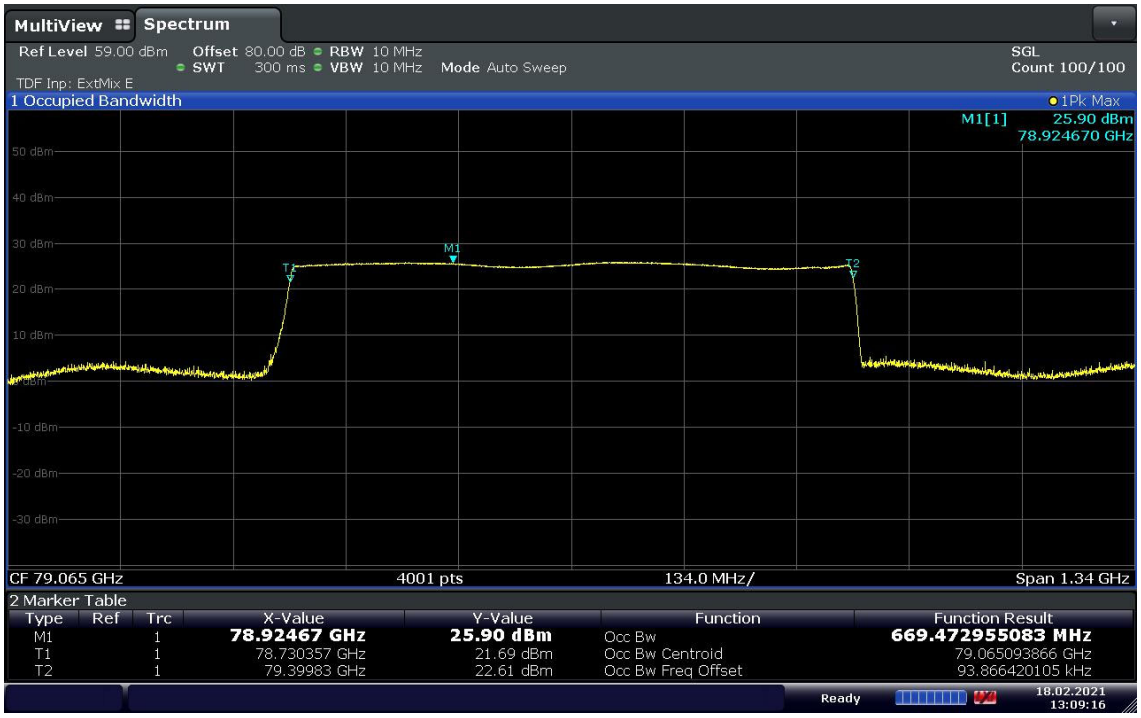
TEST CONDITIONS:		Occupied Channel Bandwidth
T nom	V nom	1 907.758 MHz

*** High Resolution**

▣ RESULT PLOTS

Occupied Bandwidth plot (Long Range)

Occupied Bandwidth plot (Mid Range)



Occupied Bandwidth plot (High Resolution)

7.2 Radiated Power

Test Requirements and limit, § 95.3367

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:
(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).
(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

Technical requirements, KDB 653005 D01 v01 r01

b) The maximum fundamental emission power (EIRP) shall be measured using a power averaging (rms) detector with a 1 MHz resolution bandwidth (RBW) and integrated over the full 99% occupied bandwidth (OBW) to obtain the data necessary to demonstrate compliance to the 50 dBm limit.
c) The maximum peak fundamental emission power (EIRP) measurement shall be performed by sweeping over the transmitted occupied bandwidth using a positive peak power detector with peak hold activated, and a 1 MHz RBW. Power integration is not to be used in performing this measurement. The resultant peak power spectral density (maximum in any 1 MHz) data shall be used to demonstrate compliance to the 55 dBm/MHz limit. 1) Peak power measurements of swept frequency radar implementations (e.g., high sweep rate FMCW) may require a desensitization correction factor to be applied to the measurement results. See relevant Application Note(s) from the measurement instrumentation vendor for details.
2) A pulse desensitization factor may have to be applied to peak power measurement results depending on the pulse width and/or period. See relevant Application Note(s) from the measurement instrumentation vendor for details.

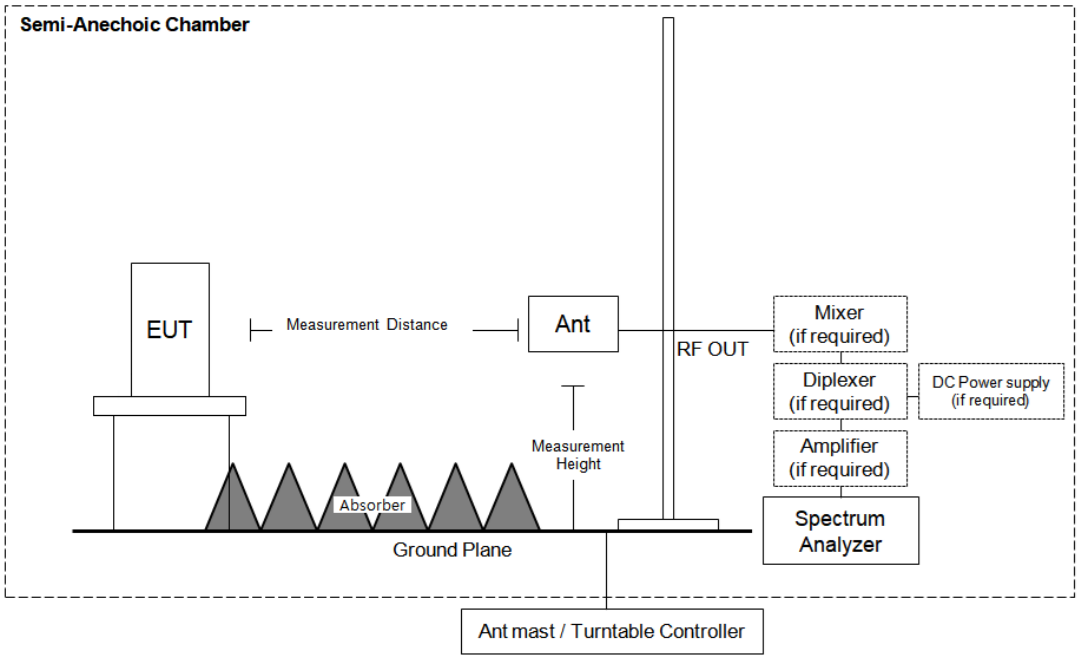
ISED Rules

RSS-251, 8, 9 Average equivalent isotropically radiated power (e.i.r.p.)
The average e.i.r.p. measurement shall be performed using a power averaging detector with a 1 MHz resolution bandwidth (RBW). The power shall be integrated over the occupied bandwidth.

RSS-251, Peak e.i.r.p. spectral density
The peak e.i.r.p. measurement shall be performed by sweeping the transmitted occupied bandwidth with a positive peak power detector, using a peak hold display mode, and a 1 MHz resolution bandwidth. The power integration is not to be used in performing this measurement.

Test Configuration

40 GHz – 243 GHz



▣ TEST RESULTS

Long Range

Frequency	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[H/V]	[dBm]	[dBm]	[dB]	
79.04	H	25.91	55	29.09	PK
79.04	H	20.71	50	29.29	AV

Mid Range

Frequency	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[H/V]	[dBm]	[dBm]	[dB]	
79.065	H	23.07	55	31.93	PK
79.065	H	20.73	50	29.27	AV

High Resolution

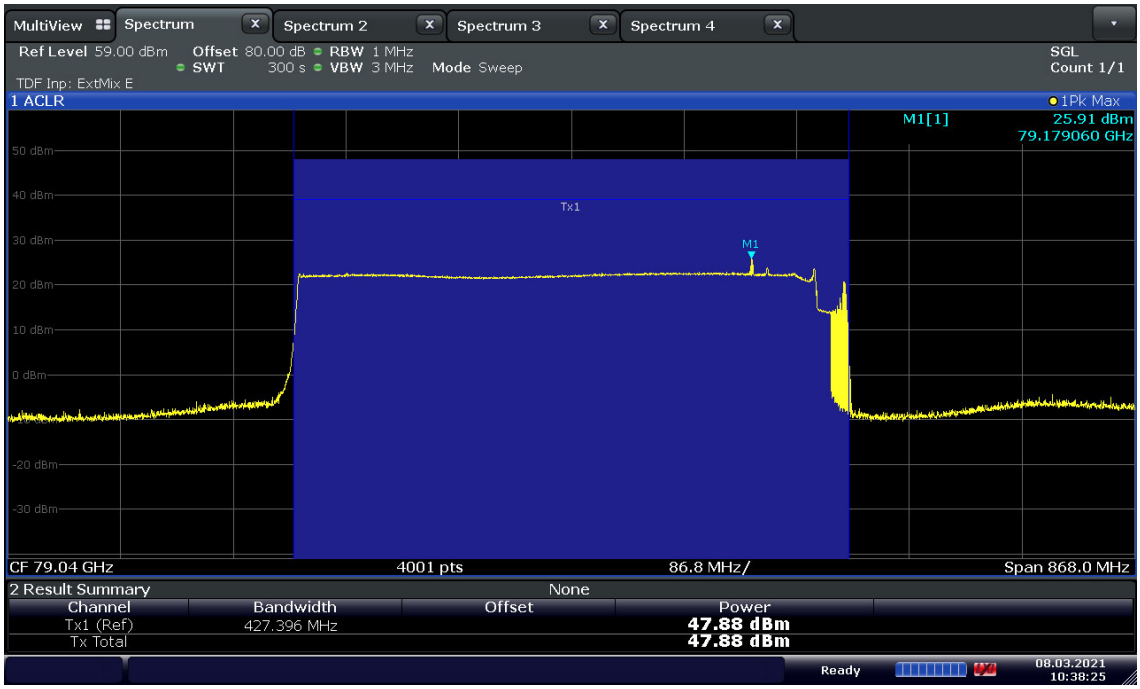
Frequency	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[H/V]	[dBm]	[dBm]	[dB]	
79.163	H	17.88	55	37.12	PK
79.163	H	19.43	50	30.57	AV

Note :

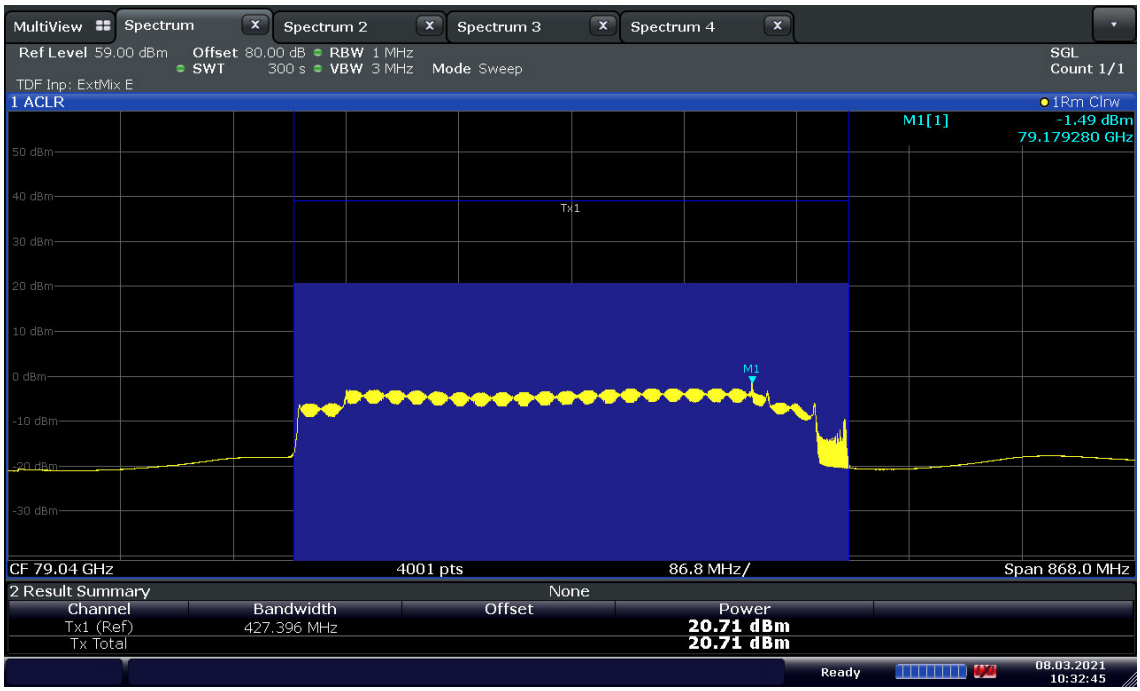
1. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
2. The total value included antenna factor, cable loss, conversion loss, and free space path loss.

▣ RESULT PLOTS

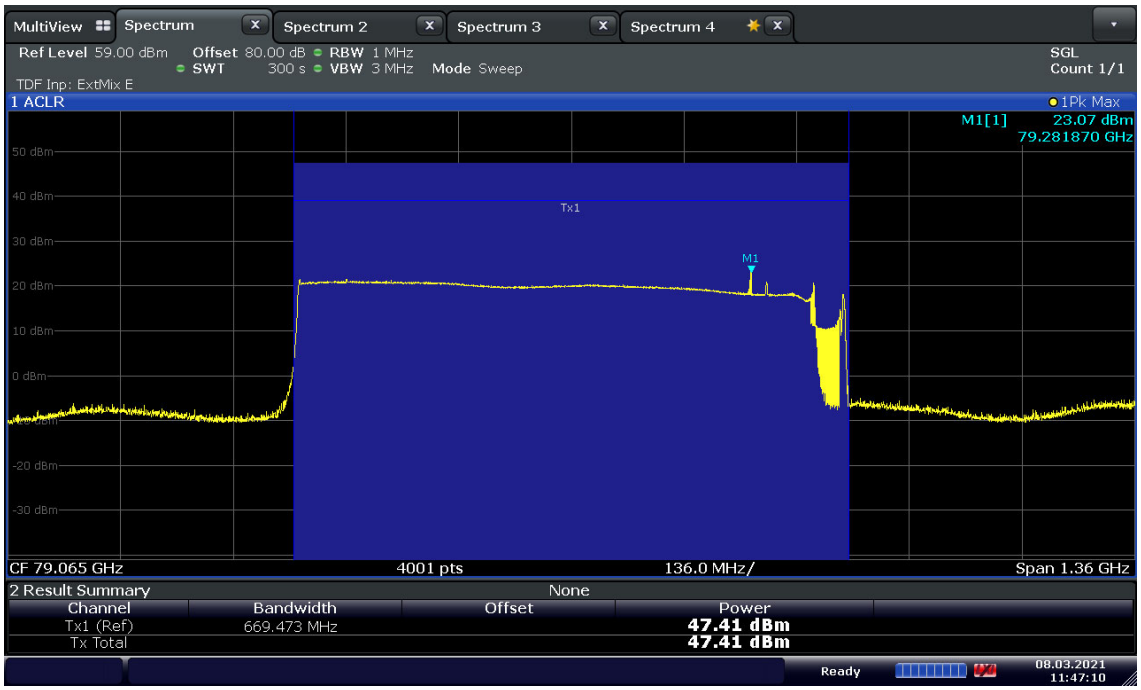
Plot (Peak) _ Long Range



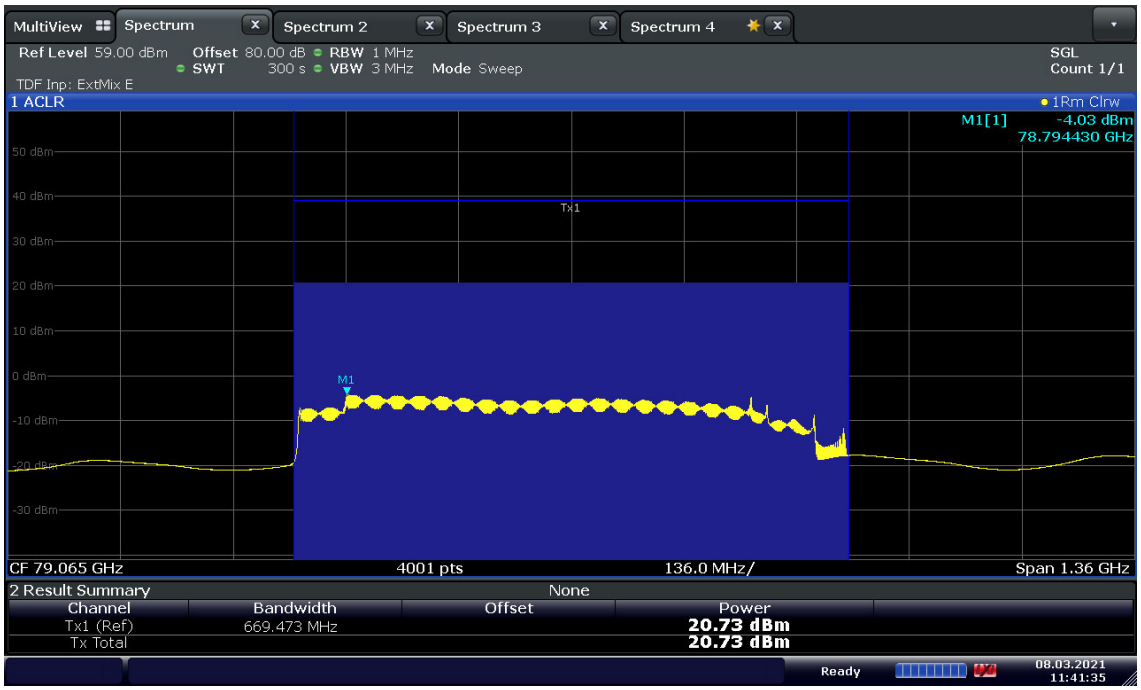
Plot (Average) _ Long Range



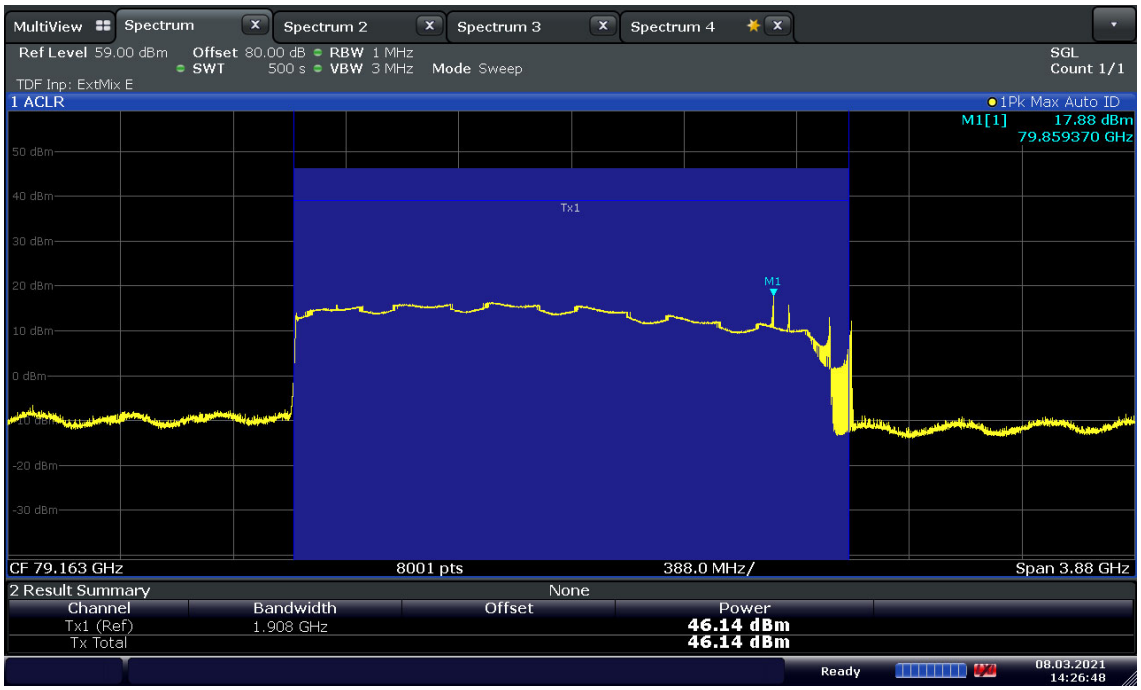
Plot (Peak) _ Mid Range



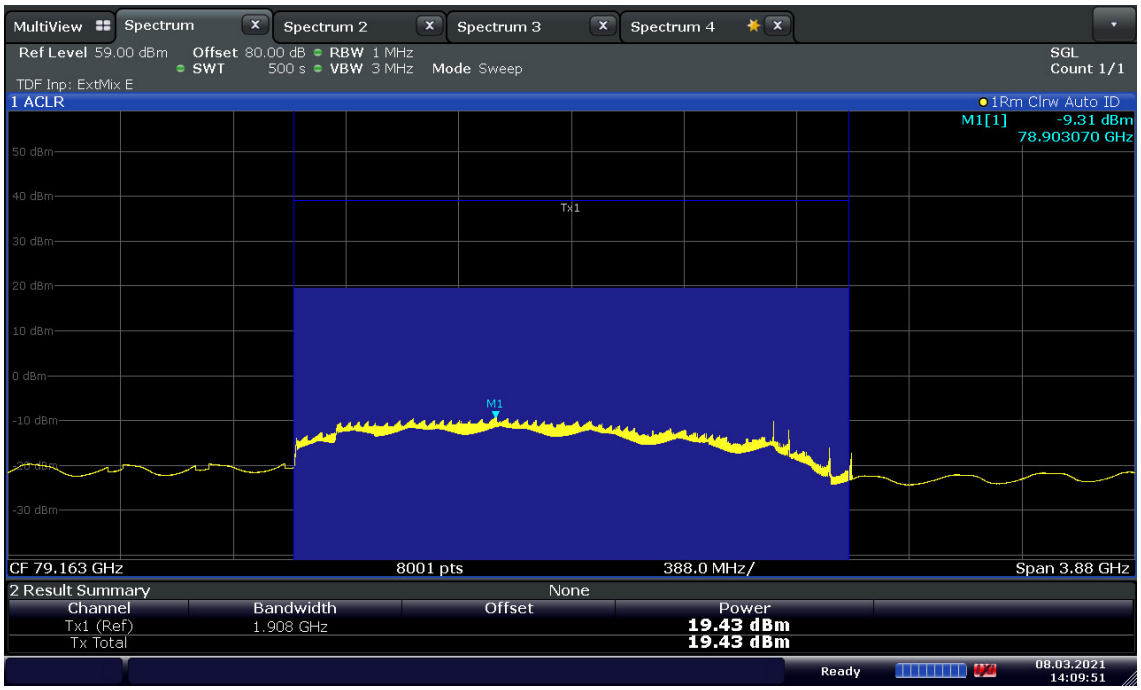
Plot (Average) _ Mid Range



Plot (Peak) _ High Resolution



Plot (Average) _ High Resolution



7.3 Unwanted emissions

Test Requirements and limit, § 95.3379

The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meter)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

(i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.

(ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

ISED Rules

RSS-251, 10 **Unwanted emissions**

Emission frequency range	Limit	Applicable detector
Below 40 GHz	RSS-Gen general field strength limits for licence-exempt radio apparatus	RSS-Gen requirements
40-162 GHz	-30 dBm/MHz(e.i.r.p.)	RMS detector

RSS GEN, 7.3 **Receiver radiated emission limits**

Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna ports. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver or 30 MHz, whichever is higher, to at least five times the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz. Spurious emissions from receivers shall not exceed the radiated emissions limits shown in Table3.

Table 3 – Receiver radiated emissions limits

Frequency (MHz)	Field Strength (μv/m at 3 metres)*
30-88	100
88-216	150
216-960	200
Above 960	500
30-88	100
88-216	150

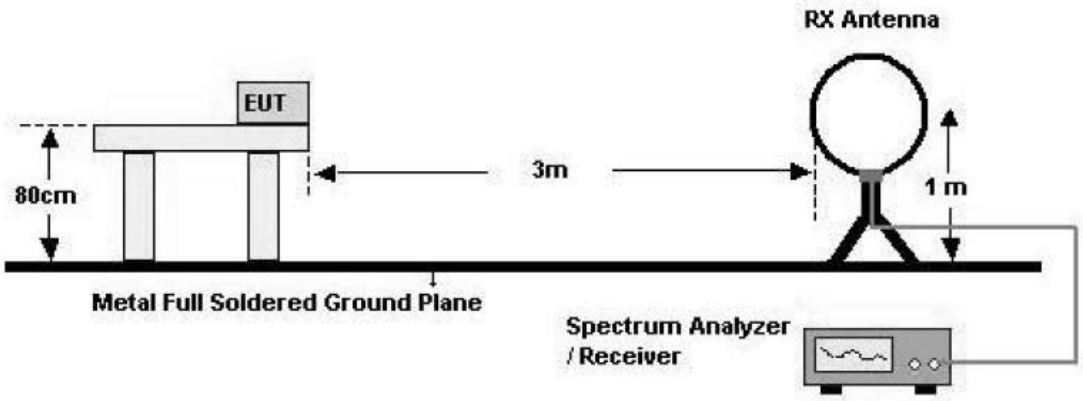
Footnote : Measurements for compliance with the limits in table 3 may be performed at distances other than 3 metres, in accordance with section 6.6.

Test Procedure

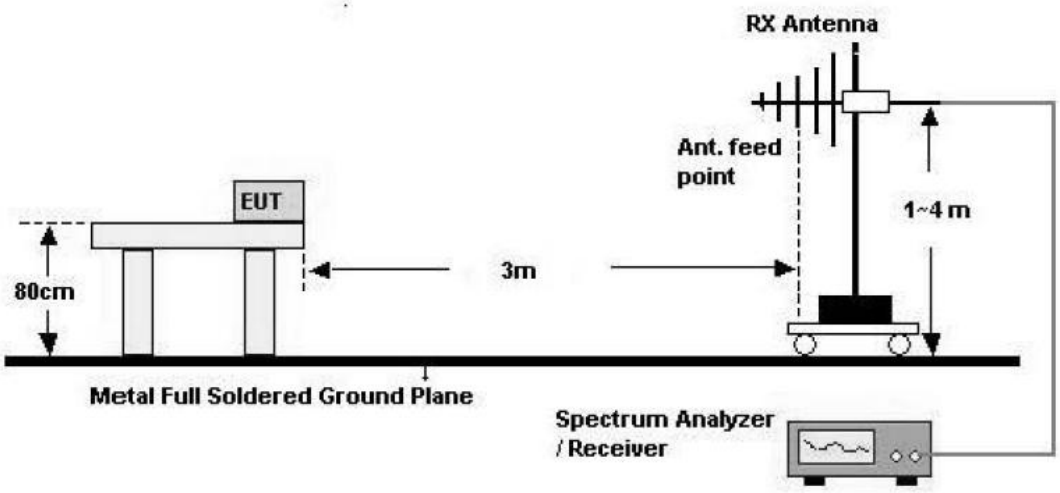
1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Repeat above procedures until the measurements for all frequencies are complete.

Test Configuration

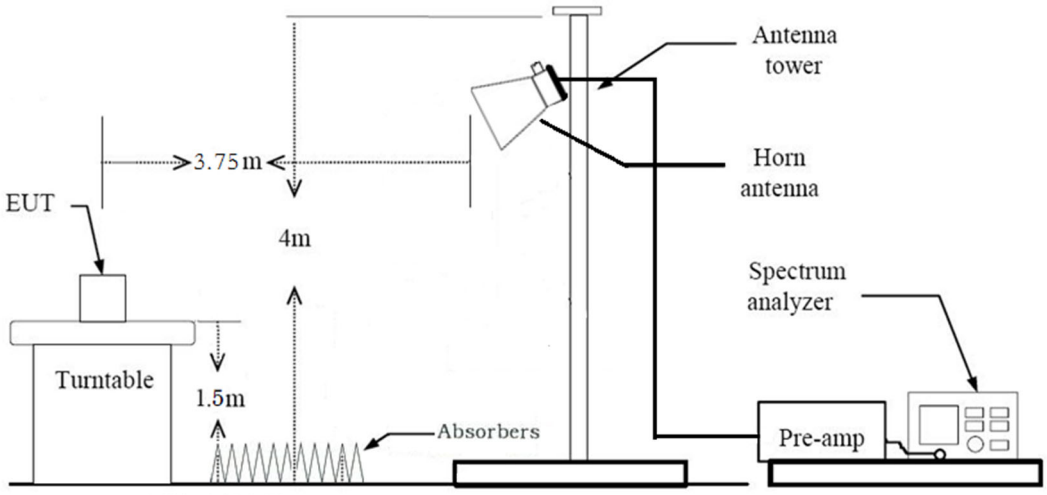
Below 30 MHz



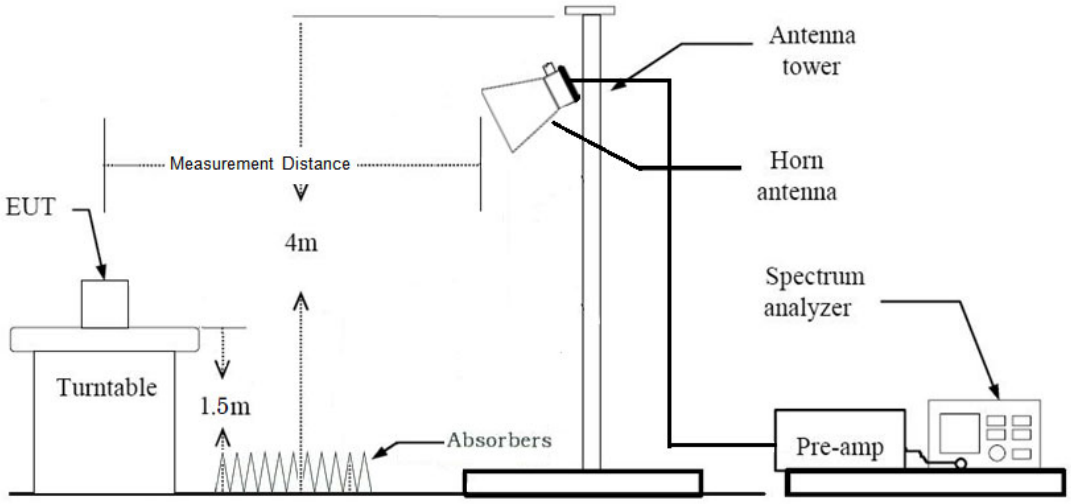
30 MHz - 1 GHz



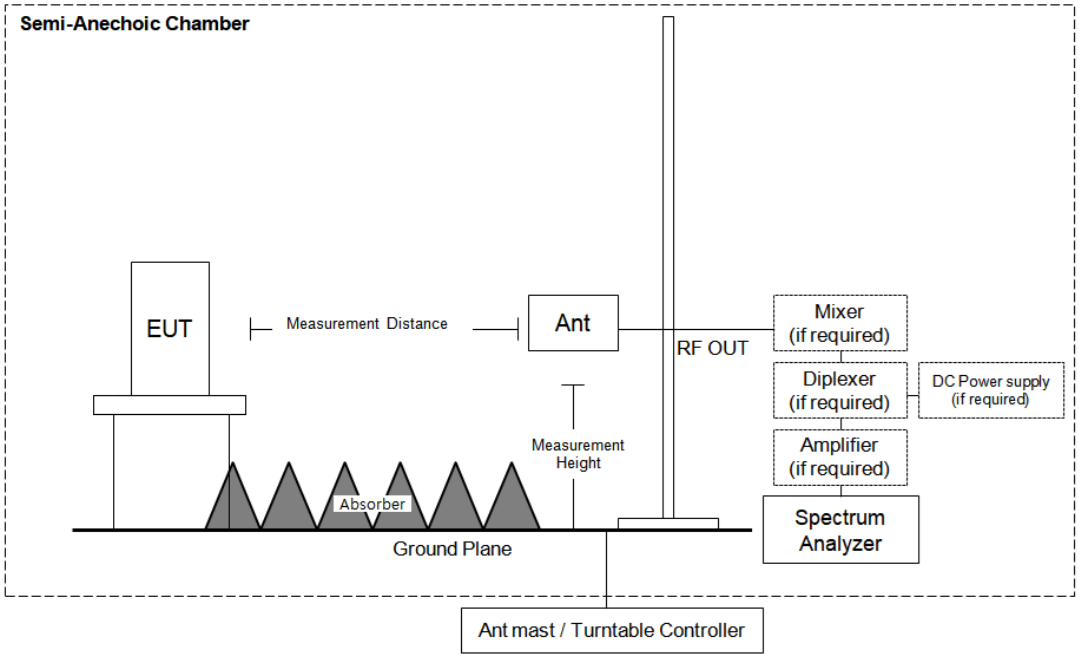
1 GHz – 18 GHz



18 GHz – 40 GHz



40 GHz – 243 GHz



▣ **TEST RESULTS**

9 kHz – 30MHz

Operation Mode: Continuous TX Mode_Short Distance Device

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Operation Mode: Continuous TX Mode_ Long Range

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
6. The test results for below 30 MHz is correlated to an open site.
   The result on OFTS is about 2 dB higher than semi-anechoic chamber(10 m chamber)

Below 1 GHz

Operation Mode: Continuous TX Mode_ Short Distance Device

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Operation Mode: Continuous TX Mode_ Long Range

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

1 GHz – 18 GHz

Operation Frequency: Continuous TX Mode_ Short Distance Device

Frequency	Reading	A.F.+C.L.-AMP G +D.F.	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	[dBuV/m]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	
No Critical peaks found							

Operation Frequency: Continuous TX Mode_ Long Range

Frequency	Reading	A.F.+C.L.-AMP G +D.F.	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	[dBuV/m]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	
No Critical peaks found							

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

18 GHz – 40 GHz

Operation Frequency: Continuous TX Mode_ Short Distance Device

Frequency	Reading	A.F.+C.L.-AMP G +D.F.	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	[dBuV/m]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	
No Critical peaks found							

Operation Frequency: Continuous TX Mode_ Long Range

Frequency	Reading	A.F.+C.L.-AMP G +D.F.	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	[dBuV/m]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	
No Critical peaks found							

※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Note :

1. Total = Reading Value + Antenna Factor + Cable Loss + Distance Factor – Amp Gain
2. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna. Worst case is y plane and vertical polarization.

40 GHz – 90 GHz

FCC

Operation Frequency: Continuous TX Mode_Long Distance

Frequency	Measured Level	AFCL	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
76.04575	-108.81	61.91	H	-46.90	-1.70	45.20	AV
81.88926	-108.21	70.85	H	-37.36	-1.70	35.66	AV

Operation Frequency: Continuous TX Mode_Mid Distance

Frequency	Measured Level	AFCL	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
76.06525	-108.86	61.91	H	-46.95	-1.70	45.25	AV
82.00326	-107.74	70.85	H	-36.89	-1.70	35.19	AV

Operation Frequency: Continuous TX Mode_High Distance

Frequency	Measured Level	AFCL	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
74.96265	-108.66	63.72	H	-44.94	-1.70	43.24	AV
82.70088	-108.06	72.95	H	-35.11	-1.70	33.41	AV

ISED

Operation Frequency: Continuous TX Mode_Long Distance

Frequency	Reading	Factor	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
76.04575	-108.81	61.91	H	-46.90	-30.00	16.90	AV
81.88926	-108.21	70.85	H	-37.36	-30.00	7.36	AV

Operation Frequency: Continuous TX Mode_Mid Distance

Frequency	Reading	Factor	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
76.06525	-108.86	61.91	H	-46.95	-30.00	16.95	AV
82.00326	-107.74	70.85	H	-36.89	-30.00	6.89	AV

Operation Frequency: Continuous TX Mode_High Distance

Frequency	Reading	Factor	Ant. Pol.	Total	Limit	Margin	Measurement Type
[GHz]	[dBm]	[dB]	[H/V]	[dBm]	[dBm]	[dB]	
74.96265	-108.66	63.72	H	-44.94	-30.00	14.94	AV
82.70088	-108.06	72.95	H	-35.11	-30.00	5.11	AV

Note :

1. Total(dBμV/m) = Reading Value(dBm) + AFCL(dB)
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna. Worst case is y plane and horizontal polarization.
3. In this test, AFCL factor consists of antenna factor, cable loss, mixer loss, amplifier gain
4. AV: Average
5. Band edge test results.

90 GHz – 243 GHz

Operation Frequency: Continuous TX Mode_ Short Distance Device

Frequency	Reading	A.F.+C.L.-AMP G +D.F.	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	[dBuV/m]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	
No Critical peaks found							

Operation Frequency: Continuous TX Mode_ Long Range

Frequency	Reading	A.F.+C.L.-AMP G +D.F.	ANT. POL	Total	Limit	Margin	Measurement Type
[MHz]	[dBuV/m]	[dBm]	[H/V]	[dBuV/m]	[dBuV/m]	[dB]	
No Critical peaks found							

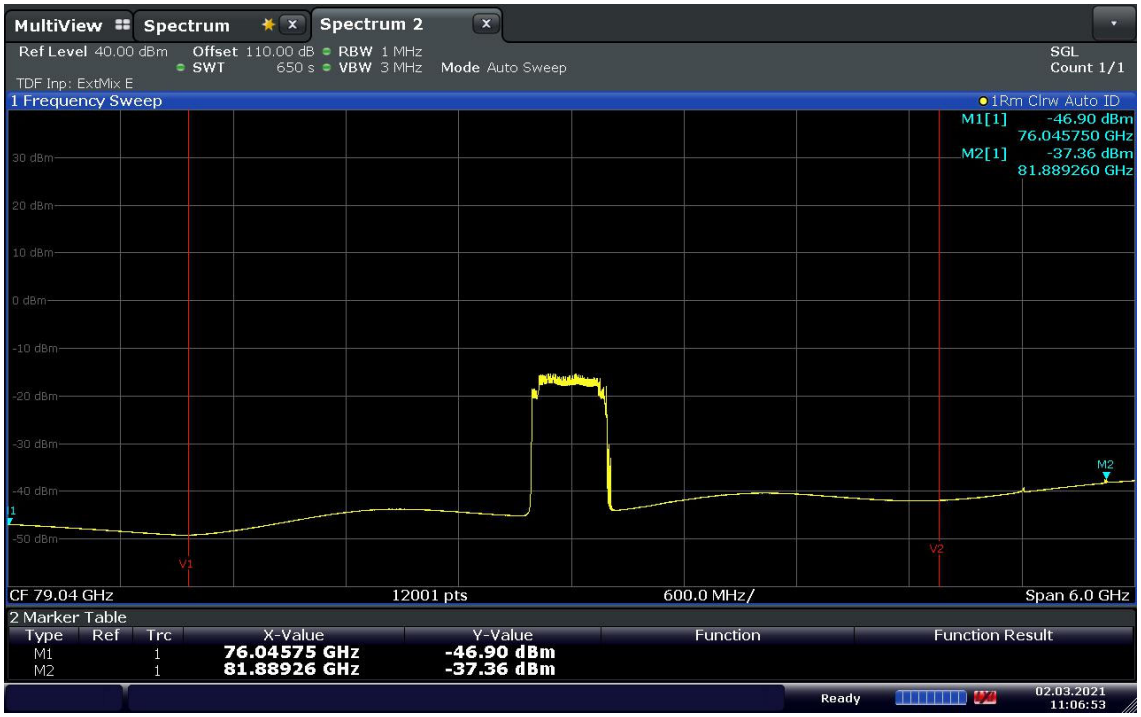
※ A·F: ANTENNA FACTOR
C·L: CABLE LOSS
AMP G: AMPLIFIER GAIN

Notes:

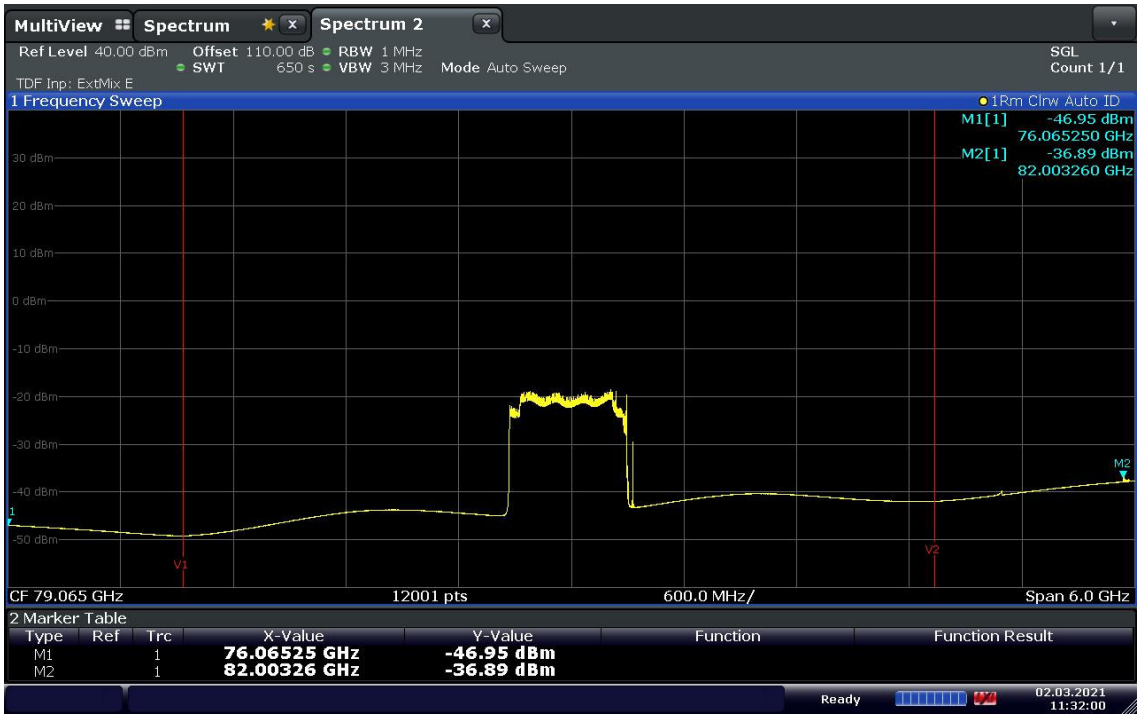
1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss – Amplifier Gain + Distance Factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

▣ RESULT PLOTS

Band Edge Plot(average, Z-V)_ Long Range



Band Edge Plot(average, Z-V)_ Mid Range



Band Edge Plot(average, Z-V)_ High Resolution

Note : Only the worst case plots for Radiated Spurious Emissions.

7.4 Fundamental emissions (Frequency Stability)

§ 95.3379 76 ~ 81 GHz Band Radar Service unwanted emissions limits.

(b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

ISED Rules

RSS-GEN, 8.11 Frequency stability

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation.

▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

RBW = 1% to 3% of the 99% bandwidth.

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

The frequency drift was investigated for every 10 °C increment until the unit is stabilized then recorded the reading in tabular format with the temperature range of -40 to 85 °C.(Manufacturer declaration)

Voltage supplied to EUT is 12 V reference temperature was done at 20°C.

The voltage was varied by ± 15 % of nominal

▣ TEST RESULTS

Reference: 12 V at 20°c **Freq.** = 79.040 GHz

Voltage	Temp. (°C)	Frequency Rage (GHz)	Limit (GHz)	Result
12 V	+20(Ref)	78.826 ~ 79.253	76 ~ 81	Pass
	-40	78.824 ~ 79.251		Pass
	-30	78.820 ~ 79.249		Pass
	-20	78.828 ~ 79.254		Pass
	-10	78.830 ~ 79.256		Pass
	0	78.827 ~ 79.253		Pass
	+10	78.833 ~ 79.259		Pass
	+30	78.819 ~ 79.246		Pass
	+40	78.823 ~ 79.250		Pass
	+50	78.824 ~ 79.252		Pass
	+60	78.821 ~ 79.248		Pass
	+70	78.825 ~ 79.253		Pass
	+80	78.826 ~ 79.254		Pass
	+85	78.831 ~ 79.257		Pass
16 V	+20	78.823 ~ 79.249		Pass
9 V	+20	78.827 ~ 79.254		Pass

*** Long Range**

Reference: 12 V at 20°c **Freq.** = 79.065 GHz

Voltage	Temp. (°C)	Frequency Rage (GHz)	Limit (GHz)	Result
12 V	+20(Ref)	78.730 ~ 79.400	76 ~ 81	Pass
	-40	78.728 ~ 79.399		Pass
	-30	78.724 ~ 79.393		Pass
	-20	78.721 ~ 79.390		Pass
	-10	78.726 ~ 79.397		Pass
	0	78.734 ~ 79.402		Pass
	+10	78.732 ~ 79.400		Pass
	+30	78.729 ~ 79.399		Pass
	+40	78.733 ~ 79.403		Pass
	+50	78.722 ~ 79.393		Pass
	+60	78.727 ~ 79.397		Pass
	+70	78.731 ~ 79.402		Pass
	+80	78.735 ~ 79.404		Pass
	+85	78.732 ~ 79.401		Pass
16 V	+20	78.728 ~ 79.397		Pass
9 V	+20	78.733 ~ 79.404		Pass

*** Mid Range**

Reference: 12 V at 20°c **Freq.** = 79.163 GHz

Voltage	Temp. (°C)	Frequency Rage (GHz)	Limit (GHz)	Result
12 V	+20(Ref)	78.209 ~ 80.117	76 ~ 81	Pass
	-40	78.206 ~ 80.114		Pass
	-30	78.204 ~ 80.110		Pass
	-20	78.201 ~ 80.109		Pass
	-10	78.206 ~ 80.114		Pass
	0	78.210 ~ 80.118		Pass
	+10	78.214 ~ 80.121		Pass
	+30	78.211 ~ 80.119		Pass
	+40	78.204 ~ 80.111		Pass
	+50	78.205 ~ 80.111		Pass
	+60	78.209 ~ 80.118		Pass
	+70	78.212 ~ 80.120		Pass
	+80	78.201 ~ 80.110		Pass
	+85	78.210 ~ 80.119		Pass
16 V	+20	78.206 ~ 80.116		Pass
9 V	+20	78.209 ~ 80.116		Pass

*** High Resolution**

8. LIST OF TEST EQUIPMENT

Manufacturer	Model / Equipment	Calibration Date	Calibration Interval	Serial No.
Schwarzbeck	BBHA 9170 / Horn Antenna	11/29/2019	Biennial	BBHA9170541
Innco system	CO3000 / Controller(Antenna mast)	N/A	N/A	CO3000-4p
Innco system	MA4640/800-XP-EP / Antenna Position Tower	N/A	N/A	N/A
Rohde&Schwarz	FSW / Spectrum Analyzer	09/09/2020	Annual	101256
Rohde&Schwarz	FSP / Spectrum Analyzer	09/14/2020	Annual	836650/016
Emco	2090 / Controller	N/A	N/A	060520
Ets	Turn Table	N/A	N/A	N/A
Schwarzbeck	Loop Antenna / FMZB1513	05/18/2020	Biennial	1513-175
Schwarzbeck	VULB 9168 / Hybrid Antenna	09/04/2020	Biennial	9168-0895
Schwarzbeck	BBHA 9120D / Horn Antenna	09/25/2019	Biennial	9120D-1298
OML INC.	WR-19 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M19RH-160419-1
OML INC.	WR-19 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M19RH-160419-2
OML INC.	WR-12 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M12RH-160419-1
OML INC.	WR-12 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M12RH-160419-2
OML INC.	WR-08 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M08RH-160419-1
OML INC.	WR-08 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M08RH-160419-2
OML INC.	WR-05 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M05RH-160419-1
OML INC.	WR-05 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M05RH-160419-2
OML INC.	WR-03 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M03RH-160419-1
OML INC.	WR-03 Horn Antenna / Horn Antenna	04/23/2020	Biennial	M03RH-160419-2
OML INC.	OML WR19 / Harmonic Mixer	09/09/2020	Annual	M19HWD
OML INC.	OML WR12 / Harmonic Mixer	09/09/2020	Annual	M12HWD
OML INC.	OML WR08 / Harmonic Mixer	09/09/2020	Annual	M08HWD
OML INC.	OML WR05 / Harmonic Mixer	09/09/2020	Annual	M05HWD
OML INC.	OML WR03 / Harmonic Mixer	09/09/2020	Annual	M03HWD
OML INC.	WR-19 / Source Module	09/09/2020	Annual	S19MS-A-160516-1
OML INC.	WR-12 / Source Module	09/09/2020	Annual	S12MS-A-160419-1
OML INC.	WR-08 / Source Module	09/09/2020	Annual	S08MS-A-160419-1
OML INC.	WR-05 / Source Module	09/09/2020	Annual	S05MS-A-160419-1
OML INC.	WR-03 / Source Module	09/09/2020	Annual	S03MS-A-160419-1
OML INC.	Diplexer L.O / Diplexer	07/14/2020	Annual	DPL518-160419-1
CERNEX	CBL26405040 / Power Amplifier	03/23/2020	Annual	25956

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.

2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

9. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	HCT-RF-2103-FI001-P